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MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL LIII. No. 8. JUNE 1893.

Fellows of the Society are informed that post-cards containing the titles of papers to be read at the evening meetings will be sent to those who shall express their wish to receive them. Fellows desiring to receive the post-cards are requested to send their names to the Assistant-Secretary, Mr. W. H. Wesley, Burlington House, London, W.

In order to enable the Secretaries to prepare complete lists in time for the issue of the post-cards, authors are particularly requested to send in their papers not later than the Tuesday preceding the day of meeting.

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ROYAL ASTRONOMICAL SOCIETY.

VOL. LIII. JUNE 9, 1893. No. 8

Captain W. DE W. ABNEY, C.B., R.E., D.C.L., F.R.S., President, in the Chair.

Hedley Robert Beasley, Milldown School, Blandford, Dorset;
Edwin Bailey Elliott, M.A., F.R.S., Waynflete Professor of Pure Mathematics, Oxford;
Arthur E. Kennelly, Edison's Laboratory, Orange, New Jersey, U.S.A.;
Benjamin Theophilus Moore, M.A., Longwood, Bexley, Kent;
Arthur A. Rambaut, D.Sc., Royal Astronomer of Ireland, Observatory, Dunsink, co. Dublin;
Frederick Lumb Wanklyn, Grand Trunk Railway Company, Montreal, Canada,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended:—

Edmond Herbert Hills, Captain R.E., 1 Devonshire Place, W. (proposed by Capt. W. de W. Abney);
Charles Herbert Edmund Rea, 223 Norwood Road, Herne Hill, S.E. (proposed by W. S. B. Woolhouse);
William Shackleton, Computer to the Solar Physics Committee, Royal College of Science, South Kensington, S.W. (proposed by J. Norman Lockyer).

Fifty-nine presents were announced as having been received since the last meeting, including, amongst others,

A. A. Michelson, On the application of interference methods to spectroscopic measurement, presented by the author; Rev. S. Kinns, Graven in the Rock, presented by the author; Photographs of the Lick Observatory, presented by the Observatory.

Preliminary Report of the Joint Solar Eclipse Committee of the Royal Society, the Royal Astronomical Society, and the Solar Physics Committee on the Observations of the Solar Eclipse of 1893 *April* 16. By A. A. Common, LL.D., F.R.S., Secretary to the Joint Solar Eclipse Committee.

Abstract.

The Joint Committee have requested me to make the following brief report on the observations of the eclipse. This will be followed shortly by a more complete report.

The Joint Committee was formed early in 1892; a grant of money was obtained from the Government Grant Fund of the Royal Society, and preparations were at once begun. After due consideration it was decided to send out two observing expeditions, one to Fundium, on the Salum River, in Senegambia, and one to Pará-Curu, in the Province of Ceará, in the northern part of Brazil. With the exception of the work undertaken by Professor Thorpe, the whole of the observations were photographic. Three classes of work were undertaken at each station.

1st. Photographs of the Corona, in continuation of a long and very complete series already taken with the "Abney" lens, and similar photographs on three times the scale, by means of a negative enlarging lens by Dallmeyer.

2nd. Photographs of the surroundings of the Sun by means of a prism in front of the object-glass. (Prismatic camera.)

3rd. Photographs of the spectrum of the Corona by slit spectroscopes.

The West African Expedition was placed in charge of Professor Thorpe, F.R.S. Professor Thorpe, assisted by Mr. Gray and Mr. Forbes, undertook the determination of the photometric intensity of the coronal light by the method he used at the Solar Eclipse of 1886 in Granada. A complete and satisfactory series of observations was made.

Mr. A. Fowler undertook the prismatic camera observations, using a 6-inch telescope, lent by Mr. Lockyer, with a large prism in front of the object-glass. Mr. Fowler took six plates before and after totality, and fifteen during totality. The photographs are considered by Mr. Lockyer, at whose wish this investigation was made, to be of very great value.

Sergeant Kearney, R.E., had charge of the coronagraph.

With the Abney and Dallmeyer lenses and a double camera eleven pictures of the Corona were secured, which are of a most satisfactory character.

Captain E. H. Hills, R.E., undertook the slit spectroscopes, and obtained two excellent photographs.

Mr. A. Taylor and Mr. W. Shackleton formed the expedition to Brazil. The coronagraph was placed in charge of Mr. Taylor, as well as the slit spectroscopes, to be used if the necessary local help could be obtained. Twelve photographs of the solar Corona were obtained, of a similar character to those obtained in Africa, and directly comparable with them as regards exposure, density, and detail of the coronal structure. Most of those coronal plates have Captain Abney's density squares impressed upon them for determining the density of the photographic image. Two photographs with the slit spectroscopes were obtained.

Mr. Shackleton, with an arrangement somewhat similar to that employed by Mr. Fowler, took a large number of photographs; these are only less valuable than the African photographs in that the instrument employed was on a smaller scale.

The air at Fundium was hazy. At Pará-Curu the observations were made under particularly fortunate circumstances, as the Sun was clear of clouds only for a short time about the time of the eclipse.

Generally speaking, the results obtained are of a most satisfactory character. The photographs taken at each station provide a large amount of material to work upon, particularly those taken with the prismatic camera. From the distance apart of the two stations and the duplication of the work, a comparison may throw some light on the question of change of form and nature of the surroundings of the Sun during the interval between the observations. In this respect we may have the photographs taken at Chili to further extend this time interval.

The various members of the expeditions have enjoyed good health, and no one seems to have suffered injury from the excessive heat.

The Committee are under great obligations for much assistance given to the expeditions. The work of observation in Africa was made on French territory. The French Government did everything possible in granting a choice of sites, and M. Victor Allys, the French Administrator at Fundium, gave most valuable help.

The Admiralty gave us a gunboat to take the party up the Salum River and attend on them during the time this work lasted, and a cruiser brought the party from Bathurst to Grand Canary. The value of the help afforded by the Admiralty can be appreciated when it is known that without it this expedition could not have been sent.

From many other quarters most valuable aid has been received, and will be more fully acknowledged in the General Report.

The Motion of Σ 1819. By S. W. Burnham, M.A.

Since the first measures of this pair by Struve, in 1828, the companion has passed through an arc of nearly 90°. During this interval it has been frequently measured by most of the double star observers. It is always an easy pair, as the distance is never less than 1″, and the components are sensibly equal in magnitude. The only orbit of this pair was computed by Casey in 1882, using measures from 1828 to 1877 (*A. N.* 2421). Some of the measures made during this interval were omitted, but this could not materially affect the conclusion. He found a period of 340·1 years. Subsequently, Berberich challenged the correctness of this result (*A. N.* 2518), and showed that the measures could be well represented by rectilinear motion, and that therefore the relative change was probably due to proper motion. So far as one could judge alone by the residuals resulting from his comparison of the measures as a whole with a right line, a good *primâ facie* case was made; and if the claim had been simply that at this time, in consequence of the shortness of the arc and the errors of the observations, no ellipse could be drawn to represent these discordant measures, which would be more likely to be the correct orbit than any one of many others which could be substituted, there would be nothing further to be added until the observations cover a much longer time.

But when we consider all the circumstances, the proper motion of the system as a whole, the relative magnitudes, and particularly the distance between the components, and the measures, such as they are, there seems to be no reasonable doubt that these stars form a binary system. We may further consider that although the measures can be apparently well represented by rectilinear motion, still when the character as to accuracy of all such observations is taken into account, such argument has very little bearing upon the question. That these measures are many of them bad—inexcusably so—is obvious enough from a casual inspection; but they are no worse than the measures of all pairs of this class which cover a period of sixty years. If the measures which have been used in computing the orbits of any of the long-period binaries, where no question has been raised as to the character of the relative motion, were submitted to this test, it would be found in every instance that the motion could be substantially as well represented by a straight line. This will explain the enormous discrepancies in the periods of the same pair by different computers where the angular change is small. We have periods of *Castor* ranging from 250 to 1,000 years, of σ *Coronæ* from 195 to 845 years, and λ *Ophiuchi* from 89 to 370 years. Many other similar instances might be cited, but it is sufficiently evident that if two independent investigators should reach the

same result, it would be due to the accident of their treating discordant observations in the same manner. Anything from a circle to a straight line will represent the measures in nearly all of these small arcs, and the most laborious and thorough analytical investigation is not likely to give any better result than would be obtained in a moment's time by simply taking the angular motion as uniform throughout the apparent orbit. In this connection an examination of the widely differing results obtained of stars of the class under consideration, given in Gore's *Catalogue of Binary Stars*, will be instructive. There is no doubt whatever, in most instances at least, of the physical connection of these stars, but the data are wholly insufficient for the determination of the periods and other elements of the orbits. It is very questionable if it is worth while spending any time in the investigation of the orbit of any binary where the arc representing the angular motion is not at least 180°. Certainly in the majority of instances not even an approximate result can be obtained. If the measures were free from errors, then, of course, one ellipse, and only one, would represent them; but with the material we have, and particularly where it runs back nearly to the beginning of micrometrical work, a great variety of curves will satisfy the observed positions equally well, even when one-half of the orbit has been passed over. The fact is that the best-known orbits are those of double stars discovered in the last fifteen or twenty years.

In looking up the question of the motion of Σ 1819 it was necessary in the first instance to collect all the measures down to date. As these will be wanted in some future investigation, I give them here:—

Measures of Σ 1819.

Date.	P.	D.	*n*	
	°	″		
1828·35	88·0	0·86	2	Struve
1832·42	84·9	1·10	2	Struve
1836·43	76·1	1·13	4	Struve
1841·35	65·2	0·95	1	Mädler
·93	66·4	1·07	2	O. Struve
1842·40	63·2	0·87	3	Mädler
·81	60·5	1·08	3	Dawes
1843·24	62·8	...	7	Kaiser
·34	61·9	1·02	1	Dawes
·34	61·2	0·94	1	Mädler
1844·35	62·0	0·83	1	Mädler
1845·38	57·1	1·04	1	Mädler
1847·41	54·1	1·16	5	Mädler
1849·36	52·9	1·19	2	O. Struve
1851·29	49·6	1·27	5	Mädler
1852·39	46·1	1·02	1	Mädler

Date.	P.	D.	*n*	
1853·42	45°·3	1″·09	2	Mädler
1854·39	44·4	1·14	4	Mädler
1856·39	43·7	0·93	2	Secchi
·41	47·4	1·19	1	Mädler
1857·42	42·7	1·05	1	Mädler
·82	41·6	1·1	10	Dembowski
1858·38	38·2	1·0	1	Mädler
1859·45	39·4	1·00	1	Secchi
1863·01	32·3	1·29	11	Dembowski
1864·41	34·5	1·17	2	Secchi
1866·42	36·5	1·43	1	O. Struve
·49	30·5	1·21	8	Dembowski
1867·28	31·9	1·94	...	Talmage
·31	33·5	1·03	2	Searle
1868·18	34·1	0·88	1	Searle
1870·36	26·2	1·23	3	Gledhill
1871·31	26·1	1·35	3	Gledhill
·69	24·2	1·31	9	Dembowski
1872·38	24·8	1·19	2	Wilson & Seabroke
1873·32	25·3	1·28	2	Wilson & Seabroke
1874·41	23·2	1·33	1	Wilson & Seabroke
1875·36	21·6	1·47	4	Schiaparelli
·38	24·1	1·40	1	Wilson & Seabroke
1876·41	23·2	1·37	1	Wilson & Seabroke
·41	20·1	1·26	3	Hall
·59	19·9	1·18	5	Dembowski
1877·33	17·2	...	2	Doberck
·37	19·0	1·23	1	Plummer
1878·40	17·8	1·22	2	Doberck
·42	20·4	1·38	2	Wilson & Seabroke
1879·40	18·6	1·49	4	Schiaparelli
·49	19·2	1·20	2	Wilson & Seabroke
1880·37	14·3	1·34	4	Hall
1881·39	15·7	1·26	4	Hall
·45	15·9	1·56	3	Schiaparelli
·46	15·1	1·45	1	Hough
1882·30	16·2	1·27	2	Doberck
·41	14·9	1·32	3	Hall
·45	17·2	1·60	4	Schiaparelli
1883·42	13·8	1·35	2	Hall

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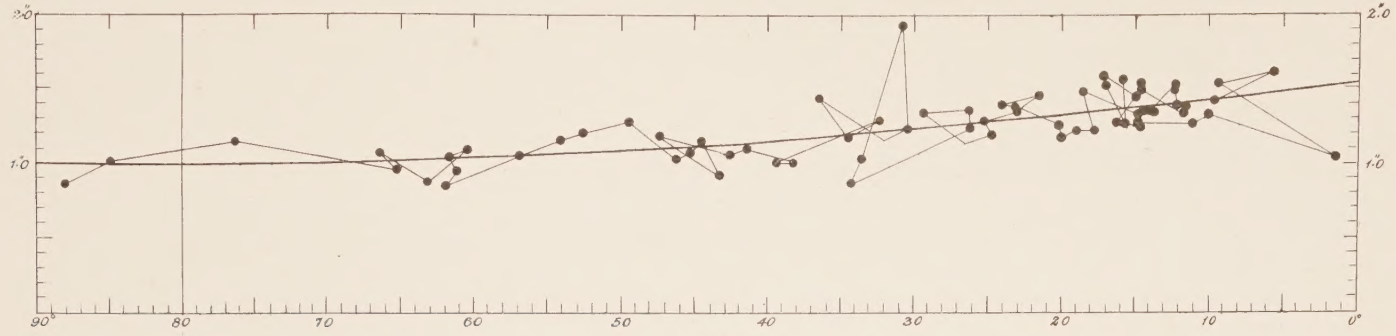

Fig. 1 Σ 1819

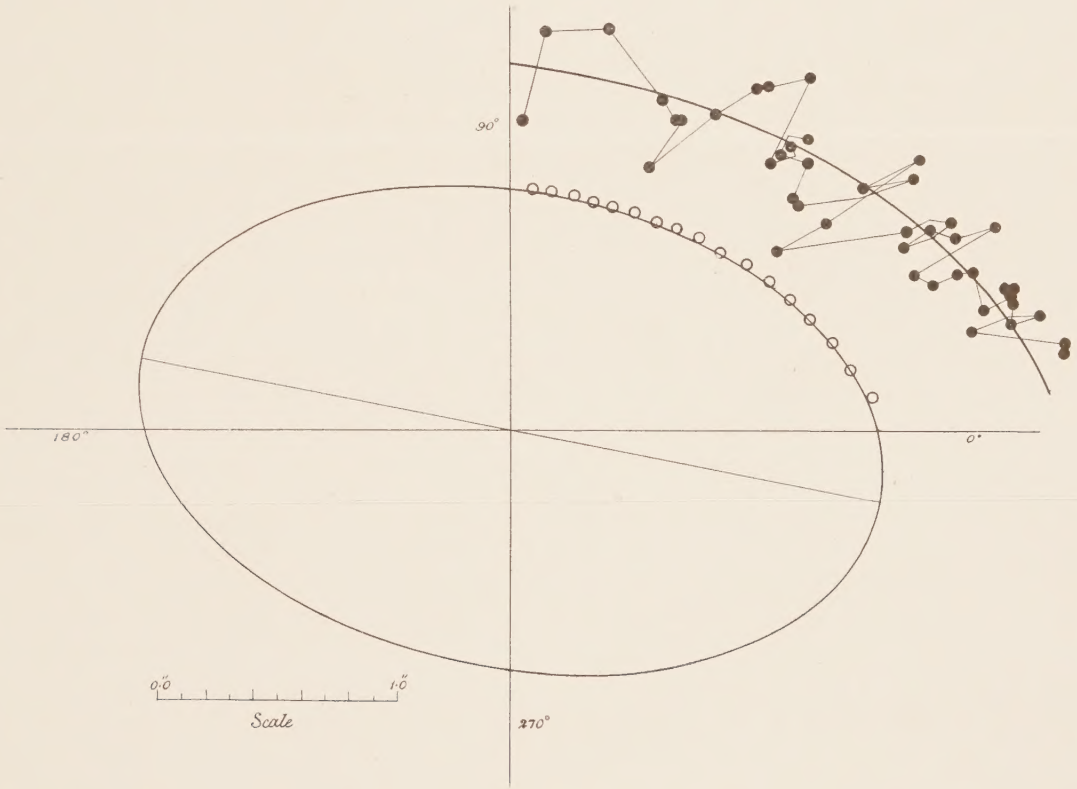

Fig. 2 Σ 1819

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Date.	P.	D.	*n*	
	°	″		
1883·46	14·6	1·53	5	Schiaparelli
·46	14·6	1·25	1	Seabroke
·85	17·0	1·52	7	Engelmann
1884·42	13·7	1·33	3	Hall
·45	14·7	1·49	5	Schiaparelli
1885·37	11·8	1·32	3	Hall
·41	11·4	1·39	2	Perrotin
·45	12·1	1·50	5	Schiaparelli
·52	12·0	...	2	Smith
1886·43	12·1	1·39	3	Hall
·47	12·2	1·54	2	Smith
1887·35	14·9	1·28	3	Tarrant
·38	11·1	1·28	4	Hall
·43	10·0	1·33	5	Schiaparelli
1888·39	8·0	...	1	Smith
1889·32	1·4	1·05	2	Highton
1890·45	9·1	1·53	2	Glasenapp
1891·46	5·7	1·62	2	Collins
·49	9·5	1·42	3	Maw

The discordances are large, and it is clear that we must in some way get a mean line which will represent as fairly as possible the path of the star as derived from all the measures. I know of no better way in this particular instance than that followed in the diagrams illustrating my paper on "Invisible Double Stars" (*Monthly Notices*, 1891 April), and I have accordingly laid down each one of these measures, when both angle and distance are given, on the diagram, plate 9, fig. 1, the angles being shown on the horizontal scales and the distances on the vertical scale. The consecutive measures are connected by lines, so that any one can be readily identified. The long curved line was then carefully drawn through these observed positions, so as to represent them as a whole as accurately as possible. The distances of points on this line at intervals of 5° were then taken from the diagram for the 85° represented by the observations, and laid down on the diagram, fig. 2, in the usual way from the central star. These seventeen positions are shown by the white circles. Then an ellipse was drawn which should pass through these several points as nearly as possible.

As a further check, and illustration of the character of the motion, I have plotted from the central star the observed positions for each year represented by measures. These are shown by the black circles outside the ellipse. Where more than one observer has measured it in a single year, a simple mean has been taken of all the measures. Only two observations have been omitted from the means, and both because the distances

were manifestly absurd. The angles and distances of the several positions were laid down with all possible accuracy, but in order to avoid confusing the two sets, the scale of distances for the observed positions is one and one-half time the scale used in laying down the first positions. The divided scale of 1″·0 shown on the diagram has reference to the white circles.

Certainly these positions appear to show orbital motion beyond all question. If there is any doubt in regard to this, then it follows as a matter of course that no binary system is positively known as such, where the period is more than 300 years.

The ellipse shown on fig. 2 gives a period of 310 years. This may or may not be somewhere near the correct time. A variety of curves may be passed through these corrected positions, where the arc is only 90°, and represent them equally well. The most that can be said of this is, that the period will not be less than 300 years, while it may be considerably longer. Casey's period of 340 years can be made to suit these positions, but in other respects it would differ, and particularly in the eccentricity. It will be observed that the real orbit shown on the diagram is circular, while the computed orbit has an eccentricity of 0·30.

In the Albany Zone Observations (*Astronomical Journal*, No. 200) Boss gives the annual proper motion of the mean of the two components as 0″·184 in the direction of 277°·2. Assuming this to be the movement of the principal star, then if the relative change is due to proper motion, the companion would have an annual motion of 0″·197 in the direction of 283°.

Chicago:
May 10.

The Orbit of 40 *Eridani*, Σ 518. By S. W. Burnham, M.A.

The double companion to 40 *Eridani* was discovered by Herschel in 1783. It was next observed by Struve in 1825, but was too difficult to measure. The measures of precision really commence with the observations of O. Struve in 1851. Since that time it has been looked after by the various double star observers, and the arc of nearly 60°, through which the small star has passed in the last forty years, is very well defined, and the measures as a whole appear to be fairly satisfactory. The mean angular change has been about one degree and a half per year, but it is obvious that the apparent ellipse is a very elongated one, and therefore the average motion for a complete revolution will be a much smaller quantity.

Though the period is long, this is an interesting binary from the large proper motion of the system. Only four stars in the northern hemisphere have a larger proper motion. This is common to the principal star, and to the binary companion which is more than 80″ distant. Hall finds a parallax for A of 0″·22, so that the system is comparatively near the Earth.

The only orbit of BC is by Gore (*Monthly Notices*, 1886 March), who used the measures down to, and including, 1883. He found a period of 139·0 years. Since that time additional measures have been made which are not well represented by the ellipse, and it is evident that this provisional orbit is not the best which can now be made.

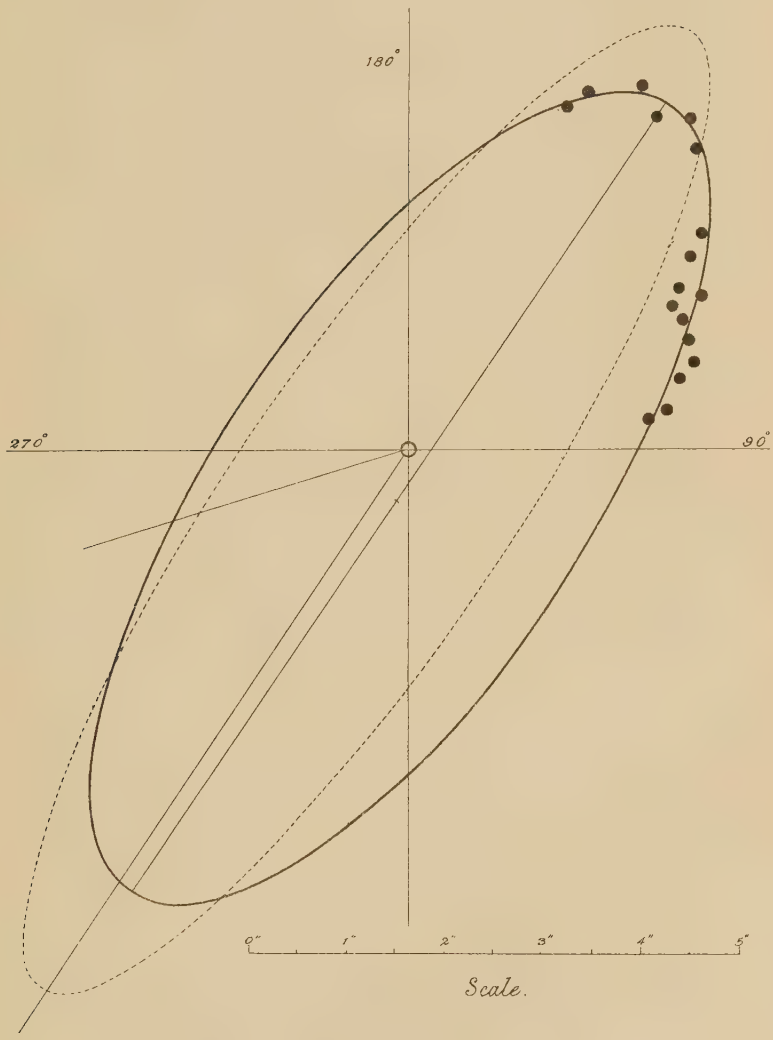
I have collected from original sources all the observations, and give them in chronological order:—

	Date.	P.	D.	*n*	
1	1783·13	326°·7	Cl. II.	1	Herschel
2	1825·12	287	...	1	Struve
3	1851·06	159·9	3″·±	1	Dawes
	·22	155·8	3·91	4	O. Struve
4	1855·06	154·0	4·14	6	O. Struve
5	1864·85	147·6	4·45	2	Winnecke
	1865·90	144·0	4·26	2	O. Struve
7	1869·10	140·4	4·46	1	O. Struve
8	1873·85	137·0	4·27	4	O. Struve
9	1877·84	128·2	3·92	6	Burnham
	·84	127·5	3·36	3	Cincinnati
	·95	126·4	3·94	4	Dembowski
10	1879·05	125·4	3·49	4	Burnham
	·11	122·9	...	1	Cincinnati
	·18	125·0	3·51	2	Hall
11	1879·75	120·0	3·29	1	Cincinnati
	80·09	121·3	3·28	5	Burnham
	80·95	122·0	3·16	5	Burnham
12	1881·84	119·0	3·53	6	Burnham
	2·12	118·1	3·24	2	Hall
13	1883·00	119·2	3·07	2	Burnham
14	1883·80	115·8	3·10	2	Hall
1	1886·00	112·2	3·22	2	Leavenworth
	·09	112·2	3·00	6	Hall
	·92	111·0	3·01	3	Tarrant
16	1888·12	107·7	3·04	5	Hall
17	1888·84	106·8	2·94	3	Burnham
	8·87	105·0	2·81	3	Tarrant
	9·12	103·5	2·79	4	Hall
18	1890·73	100·0	2·68	4	Burnham
	1·05	98·5	2·65	5	Hall
19	1891·78	97·4	2·48	4	Burnham

The two angles of Herschel and Struve, and the seventeen positions derived from the measures, as shown above, are accurately laid down on the diagram, plate 10. When more than one set of measures is used, as indicated by the brackets and corresponding marginal numbers, a simple mean is taken.

Now it is obvious that it is impossible to obtain by any method the real or apparent orbit of this pair from an arc of only 60°. A great variety of ellipses could be made which would represent these positions equally well, and which would differ widely from each other in every element. The angles of Herschel and Struve are the only means we have of deciding upon the particular form of ellipse which shall be taken to represent the orbit. In doing this it is necessary to carefully weigh the probable relative values of these angles, because it is certain that if we put all of the observations on the same footing, and distribute the errors as equally as possible over the later accurate measures and the somewhat uncertain early angles, the result will not be reliable. In 1783, when Herschel discovered this pair, it must have been a very easy object, as from the estimated distance he placed it in Class II. (4″ to 8″). He appears to have made only a single measure of the angle, but in a pair as wide as this, that should give it within a few degrees at most of the true value, even from a rough setting of the wires. Therefore we may assume that the distance was not less than 4″, and that the angle was not far from 326°. It is unfortunate that he did not make some attempt to measure the distance. Even a careful estimate at that time would be of great value now, since the errors of estimation should not much exceed 1″ in a pair of this kind.

In the position for 1825 there is much more uncertainty. This is about the only star of the class in Struve's *Mensuræ Micrometricæ* which he was unable to measure. It is not given in its proper place as a close pair in this work. It is mentioned in the section where the distant star is treated (p. 275), and again in that part of the introduction which relates to proper motion (p. cxi). It must have been seen with extreme difficulty, as otherwise it would have been observed in the usual way, and given its proper place under his Class II. in the Catalogue. The angle which he gives seems to have been regarded heretofore as some sort of measure, since one would hardly attempt to estimate a position-angle, even of the easiest pair of stars, so closely as to give it 287°. When we examine *Mensuræ Micrometricæ* carefully the explanation is very obvious. We find that this angle not only does not purport to be from a measure, but is not even an independent estimate. At this time Struve measured the angle of B from the large star, and obtained 107°. He evidently regarded C as being very nearly in line with AB, and consequently called the angle 287°. Therefore I think that all we are justified in inferring from this observation is that in 1825 the companion



40 Eridani. Σ518.

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was somewhere on the preceding side, and that the pair was close, and excessively difficult with the Dorpat telescope.

In drawing the ellipse to represent the apparent orbit there are two conditions to be met. First, it must represent as accurately as possible the observed positions from 1851 to 1892, and in this respect nothing must be sacrificed to make it conform to the earlier position-angles; and, secondly, the eccentricity and the length and direction of the major axis must be such that the areas of 1783 to 1851, and 1851 to 1892 are, as nearly as possible, proportional to the times. The uncertainty of the angle of 1825 is so great, it should not be used in determining the form of the ellipse. The result is far more likely to be correct when the other observations are depended upon.

Gore's orbit is shown on the diagram by the dotted ellipse. He has evidently made it conform to Struve's angle in 1825, since the error of that angle is only 5°·3, but in doing so it was necessary to sacrifice to some extent the measured positions of 1851 to 1883. It is obvious that this ellipse does not represent the distances at all satisfactorily. Ten of the distance measures require corrections of from 0″·70 to 0″·93. It would seem that measures by these observers, of a pair of this kind, should not have these large errors.

With the considerations in view which I have mentioned, I have drawn, after repeated trials, the ellipse shown on the diagram. It will be seen that it represents well all of the measured positions. The variations in distance are certainly not larger than the probable errors of the best observers, and the angles are correspondingly accurate. In the following table will be found the corrections to be applied to the observed distances. These values will not be sensibly affected by the small changes in the angles.

1851·22	0″·00	1881·98	−0″·03
1855·06	−0·10	1883·00	+0·30
1864·85	−0·10	1883·80	+0·08
1865·90	+0·15	1886·34	−0·08
1869·10	−0·07	1888·12	−0·22
1873·85	+0·03	1888·94	−0·12
1877·88	+0·08	1890·89	−0·10
1879·11	+0·20	1891·78	0·00
1880·26	+0·24		

According to this orbit the angle at the time of Herschel's observation in 1783 was 324°·8, and the distance 5″·35. At the date of Struve's examination the angle would be 244°·7, and the distance 1″·70. Under the circumstances this variation in the angle is not surprising. If the small star had been seen with any certainty, it would have been measured like other difficult pairs in the *Mensuræ Micrometricæ*.

From this ellipse we get the following elements :—

P = 179·7 years.	i = 69°·4
T = 1843·7	☊ = 146°·2
e = 0·142	λ = 313°·9
a = 6″·25	ω = 166°·7

According to this orbit the distance will slowly diminish until it is little more than 2″, and then gradually increase again until the maximum of nearly 5″·4 is reached, when one complete revolution will have been described since the observation of Herschel. It happens that he discovered this pair when the distance was the greatest, and Struve observed it when the distance was minimum.

I hope observers with large apertures will regularly measure this system. The angular motion should steadily increase for some years.

Chicago :
May 24.

The Orbit of Sirius. By S. W. Burnham, M.A.

In *Monthly Notices* for 1891 April (vol. li. p. 378) I gave a list of all the measures of the companion of *Sirius*, and a diagram showing the ellipse which seemed to represent the observations as a whole as well as this could be done. I did not undertake to give from this ellipse the elements of the real orbit, for the reason that this and all other orbits of *Sirius*, down to this time, are necessarily only provisional, and roughly approximate at the best, and their interest will cease as soon as the companion can be measured again. It will then be in the third quadrant, or about 180° of position-angle, and a good set of measures at that time should fix the movement of the companion with considerable certainty. For the present all we need is the apparent orbit, in order to know about where to look for the small star. In the paper referred to I gave the period according to this orbit as fifty-three years. Dr. T. J. J. See has recently examined the original diagram, and has called my attention to an error in this quantity. I have gone over the matter carefully, and find that in some way I have made a considerable error in the period as published in my paper.

In the course of this re-examination I have deduced the remaining elements from this ellipse as follows :—

P = 51·97 years.	i = 50°·8
T = 1893·5	☊ = 40°·3
e = 0·568	λ = 135°·4
a = 8″·31	Per. (app.) = 253°·0

Whatever the final orbit may be, I do not think any other can be made at this time to better represent the observations. It will be seen that this differs from Auwers' orbit of the theoretical star (*Ast. Nach.* 3084) by 2·57 years in the period. In some of the other elements the difference is a little more.

Chicago:
May 30.

Probable Errors of Greenwich Observations of Close Circumpolar Stars. By T. Lewis.

In the *Monthly Notices* for 1889 April, Mr. Downing gives the probable error of a result for R.A. as obtained with the Greenwich transit circle at different zenith distances, and for the four close circumpolar stars. He finds for λ *Ursæ Minoris*, δ *Ursæ Minoris*, and *Cephei* 51, whether above or below pole, sensibly the same result in equatorial arc, viz., $\pm^{s}\cdot 030$; but for *Polaris* the result is $\pm^{s}\cdot 020$.

This probable error includes not only the errors of observation, but those of the determinations of instrumental position. In nearly all cases where these stars have been kept "for place," the azimuthal error has been deduced from consecutive transits of *Polaris*, which doubtless accounts for the smaller value of the resulting probable error in the case of *Polaris*.

The results obtained by Mr. Downing for the circumpolars relate to eye and ear observations, whether over the fixed galvanic wires or over the same wire set to different readings of the transit micrometer. From 1889 January 1 these stars have been observed chronographically by moving the centre wire with the transit micrometer until the star is accurately bisected, and recording the instant of bisection on the chronograph with the left hand. Moreover, the list of circumpolar stars under constant observation at Greenwich has been increased (since 1888 September) by the addition of all those whose ephemerides are given in the *Connaissance des Temps*, or M. Lœwy's Annual Tables.

The following additional information with regard to the observation of close circumpolars is therefore of interest:—

(1) *The errors of bisection* and *of eye and ear estimates.* The separate bisections, or estimates of transits, were reduced to the centre wire and compared with the mean result. Observations of the close circumpolar stars, made both before and after 1889 January 1, were considered, and the results for each of the four regular observers kept separate. The probable errors are reduced to the equator.

Observer.	λ Ursæ Min.		Polaris.		Cephei 51.		δ Ursæ Min.	
	E. and E.	Chron.	E. and E.	Chron.	E. and E.	Chron.	E. and E.	Chron.
	s	s	s	s	s	s	s	s
A. D.	±·013	±·016	±·011	±·019	±·023	±·021	±·024	±·018
T.	±·015	±·019	±·015	±·023	±·020	±·026	±·021	±·024
L.	±·010	±·017	±·013	±·016	±·017	±·022	±·023	±·020
H.	±·016	±·023	±·016	±·019	±·020	±·030	±·030	±·027
Mean	±·014	±·019	±·014	±·019	±·020	±·024	±·027	±·022

The probable error of an estimate is thus smaller than that of a bisection, which would seem to point to the E. and E. method being the more accurate for stars very near the pole. It is to be remarked, however, that in the eye and ear method the readings of the micrometer screw, and consequently the times of transit, were separated by equal intervals, and there might be a tendency to equalise the recorded intervals. In the chronographic method the intervals are quite unknown, and thus the observations are entirely independent. This, therefore, may readily be one of the cases where a smaller probable error indicates an inferior observation.

It is further to be remarked that the error of bisection increases with the N.P.D. To bring this out more prominently, other circumpolar stars were examined, and also a large number further from the pole. Some differences are shown by the several observers, but a detailed examination of these peculiarities is not made on this occasion.

TABLE II.

Star.	N.P.D.	P.E.	Group. N.P.D.	P.E. Above Pole.	P.E. Below Pole.
	° ′	s	° °	s	s
λ Ursæ Minoris	1·2	±·019	5–10	±·023	±·025
Groombridge 1119	1·2	±·018	10–15	·034	·035
Polaris	1·20	±·019	15–20	·039	·038
Bradley 1672	1·41	±·020	20–25	·040	·042
Groombridge 2283	2·20	±·019	25–30	·042	·044
Cephei 51	2·47	±·024	30–40	·049	·045
Bradley 3147	3·19	±·024	40–50	·054	·055
δ Ursæ Minoris	3·23	±·022			
2 Ursæ Minoris	4·20	±·028			
Bradley 2993	4·27	±·032			

The error is thus sensibly the same above and below pole to considerable polar distances, but the increase with distance from the pole is very marked up to 50°, when, from a discussion made by Mr. E. Dunkin, it would appear to remain practically constant. Here the chronographic method clearly showed to advantage.

Mr. Dunkin's results in 1864* :—

N.P.D.	Probable Error of one Wire E. and E.	Chronographic.
° °	s	s
60–70	± ·089	± ·052
70–80	·082	·052
80–90	·073	·051
90–100	·070	·051
100	·070	·050

(2) As regards *the error of a result for R.A.*, there is, of course, nothing to add to Mr. Downing's results, except in the case of the four close circumpolar stars. Assuming $\pm^{s}\cdot030$ as the P.E. of a resulting R.A. for λ *Ursæ Minoris*, *Cephei* 51 and δ *Ursæ Minoris*, and $\pm^{s}\cdot020$ for *Polaris* from the E. and E. method, we should get theoretically for the P.E. of result for R.A. by the chronographic method:

	s
λ Ursæ Minoris and Cephei 51	± ·031
δ Ursæ Minoris	± ·029
Polaris	± ·021

The actual P.E.'s from the observations in 1889 and 1890 (chronographic method) are :—

	s
Cephei 51	± ·031
δ Ursæ Minoris	± ·0295
λ Ursæ Minoris	± ·026
Polaris	± ·021

Agreeing well with the indirect method of combining error of bisection and instrumental error, except in the case of λ *Ursæ Minoris*.

* *Monthly Notices*, vol. xxiv., p. 154.

Observations of the Satellites of Saturn in 1893.
By the Rev. Alex. Freeman, M.A.

The observations were made with a refractor equatorially mounted and having an aperture of $6\frac{1}{2}$ inches; the focal length is nearly thirteen times the aperture. The power used was 116, being found most suitable for the purpose. By the term conjunction is meant a coincidence of position on a line normal to the ring-axis of *Saturn*. Results only are given for the moment of conjunction, though divergence from conjunction within 5^m before and after the actual conjunction was usually also noted. Greenwich Mean Time is employed.

February 3^d 12^h $14^m{\cdot}7$, *Enceladus* seen very near west elongation, due $12^h{\cdot}35$.

February 3^d 13^h $17^m{\cdot}4$, *Enceladus* was co-linear with *Tethys* and *Dione*, both south of line of ring-axis.

February 3^d 13^h $38^m{\cdot}0$, *Rhea* and *Tethys* very nearly in conjunction normally to ring-axis, and about one equatorial diameter of ♄ preceding west end of ring. The calculated distances of Rh. and Te. from polar axis of ♄ are $44''{\cdot}66$ and $44''{\cdot}46$ for the observed time.

February 14^d 12^h 1^m, *Rhea* very closely followed north part of ball of ♄, and was not yet up to the east tangent at end of *Saturn's* equator.

March 15^d 10^h 40^m, *Tethys* not yet up to west end of ring, cloudy soon after. (Te. θ, $10^h{\cdot}7$, Marth.)

March 19^d 11^h 18^m, *Tethys* half-ansa length from the ball of ♄ east. Within $0''{\cdot}9$ of tabular place.

April 12^d 11^h $45^m{\cdot}2$, *Dione*, south preceding, opposite middle point of line joining inner and outer ring-ends.

April 17^d 11^h $5^m{\cdot}7$, *Tethys* not quite up to east end of ring. 11^h $8^m{\cdot}2$, *Tethys* almost quite up. It then became cloudy. (Te. ζ, $11^h{\cdot}2$, Marth.)

April 20^d 9^h $53^m{\cdot}5$, *Dione* now fully up to east ring-end, south. (Di. ζ, $10^h{\cdot}1$, Marth.)

April 23^d 10^h 44^m, *Dione* was in conjunction with west end of Cassini division, south of ring.

April 23^d 11^h 19^m, *Dione* in conjunction with west end of ring, south. (Di. η, $11^h{\cdot}4$, Marth.)

April 30^d 10^h $49^m{\cdot}8$, *Titan* is now on the south polar axis of *Saturn* produced. The distance between the limbs of

Titan and *Saturn* equal to the polar radius of *Saturn*. The Washington N.A. gives inferior conjunction south at $11^h\ 14^m{\cdot}2$ G.M.T.

April $30^d\ 10^h\ 55^m$, *Tethys*, *Dione*, and *Iapetus* nearly co-linear, *Dione* perhaps a little east of the line.

May $5^d\ 9^h\ 23^m{\cdot}5$, *Tethys* just up to west ring-end north. $9^h\ 33^m{\cdot}5$ decidedly past. (Te. θ, $9^h{\cdot}6$, Marth.)

May $5^d\ 11^h\ 7^m{\cdot}5$, *Dione* just up to west ring-end north. (Di. θ, $11^h{\cdot}2$, Marth.)

May $9^d\ 11^h\ 19^m$, *Tethys* very little beyond east ring-end north. (Te, ϵ, $11^h{\cdot}1$, Marth.)

May $10^d\ 10^h\ 17^m$, *Tethys* had a little passed west ring-end south. (Te. η, $9^h{\cdot}7$, Marth.)

May $16^d\ 9^h\ 13^m{\cdot}5$, *Titan* had passed the south polar axis produced by one-fifth of the equatorial radius of ♄. He was distant from the south pole at least the polar radius of ♄. Washington N.A. gave inferior conjunction south at $9^h{\cdot}23$ G.M.T. (An observer at Brighton with $10\frac{1}{2}$-inch reflector made *Titan* to be on the polar axis at $8^h\ 55^m$.)

May $16^d\ 9^h\ 54^m$, *Dione* in conjunction with west ring-end north. (Di. θ, $9^h{\cdot}9$, Marth.)

May $27^d\ 8^h\ 34^m{\cdot}4$, *Dione* in conjunction with west ring-end north. (Di. θ, $8^h{\cdot}6$, Marth.)

May $27^d\ 9^h\ 27^m{\cdot}4$, *Tethys* in conjunction with Cassini division at west end, south.

May $27^d\ 9^h\ 38^m{\cdot}9$, *Tethys* in conjunction with west ring-end south. (Te. η, $9^h{\cdot}5$, Marth.)

June $2^d\ 8^h\ 53^m$, *Rhea* in conjunction with *Tethys* on the west of *Saturn*. The distance of the centres of the satellites about equal to polar radius of ♄. By Marth's ephemeris, *Rhea* $44''{\cdot}29$ west and $7''{\cdot}01$ north, whilst *Tethys* $44''{\cdot}38$ west and $0''{\cdot}27$ south. Polar radius of *Saturn* is $8''{\cdot}02$. The agreement in distance from the polar axis of ♄ is within $0''{\cdot}1$.

Murston Rectory, Sittingbourne:
1893 *June* 5.

Observations of Comet 1892 *d* (*Brooks*) *made at the Royal Observatory, Cape of Good Hope.*

(*Communicated by D. Gill, LL.D., F.R.S., H.M. Astronomer.*)

1893.	Cape Mean Time.	Comet−Star. Δ *a*.	Comet−Star. Δ *δ*.	No. of Comps.	Observer.	Comet's App. R.A.	Log. ($p\times\Delta$).	Comet's App. Dec.	Log. ($p\times\Delta$).	Reduction to App. Place.	Comp. Star No.
	h m s	m s	′ ″			h m s		° ′ ″		s	″
Jan. 16	14 59 51·2	−1 25·21	+2 55·8	9-8	F.	15 42 43·32	9·8014*n*	−41 55 31·6	0·3625*n*	−1·66	+4·1 1
18	15 3 20·9	−3 9·37	+0 54·1	6-8	F.	15 52 3·89	9·8005*n*	−42 4 28·3	0·3477*n*	−1·63	+3·4 2
23	14 46 55·9	−0 49·06	+1 8 1	12-12	F.	16 14 9·50	9·8113*n*	−42 14 27·0	0·4190*n*	−1·54	+2·2 3
24	14 49 26·6	−1 17·78	−1 8·7	12-12	F.	16 18 23·45	9·8104*n*	−42 14 33·6	0·4110*n*	−1·53	+1·9 4
28	14 56 34·5	−2 16·48	+1 39·3	12-8	F.	16 34 36·80	9·8068*n*	−42 9 39·9	0·3883*n*	−1·45	+0·9 5
30	14 46 35·9	−0 45·17	+3 45·8	12 8	F.	16 42 15·92	9·8107*n*	−42 4 26·1	0·4237*n*	−1·39	+0·5 6
Feb. 16	14 59 48·4	+2 0 64	−4 0·4	12-8	F.	17 36 44·85	9·7872*n*	−40 28 26·7	0 3547*n*	−0·93	−2·2 7
18	14 52 55·5	+1 11·91	−1 54·0	12-8	F.	17 41 55·59	9·7883*n*	−40 13 17·9	0·3740*n*	−0·87	−2·4 8
19	14 44 59 2	+1 43·91	−2 15·7	12-8	F.	17 44 25·19	9·7902*n*	−40 5 36·5	0·3993*n*	−0·84	−2·5 9
20	14 52 8·7	−2 29·21	−2 44·9	12-8	F.	17 46 52·21	9·7848*n*	−39 57 41·5	0·3701*n*	−0·83	−2·7 10
21	14 44 7 8	−0 42·47	−0 12·2	12-8	F.	17 49 14·62	9·7876*n*	−39 49 45·6	0·3964*n*	−0·79	−2·7 11
22	14 44 15·4	−1 30·56	−2 9·8	12-8	F.	17 51 34·15	9·7859*n*	−39 41 40·2	0·3915*n*	−0·77	−2·8 12
Mar. 16	14 54 19·8	−1 49·96	−1 45·2	11-8	F.	...	9·7188*n*	...	0·2248*n*	−0·09	−3·8 13
17	14 50 10·4	+3 13·46	+1 1·3	12-8	F.	...	9·7190*n*	...	0·2358*n*	−0·03	−3·8 14
18	14 41 40 0	−1 8·35	+1 10·5	12-8	F.	...	9·7245*n*	...	0·2610*n*	−0·02	−3·8 15
22	14 54 54·0	−2 29·68	+0 30·3	12-8	F.	18 34 39·78	9·6894*n*	−35 44 21·2	0·1691*n*	+0·11	−3·9 16
25	14 49 42·0	+1 31·33	−4 0·0	12-8	F.	18 36 53·92	9·6810*n*	−35 19 22·8	0·1635*n*	+0·23	−4·0 17
26	14 52 11·6	+2 10·06	+4 16·6	12-8	F.	18 37 32·68	9·6719*n*	−35 11 6·2	0·1418*n*	+0·26	−4·0 17
Apr. 14	14 8 36·1	+0 31·84	−0 53·3	12-8	F.	...	9·6134*n*	...	0·1225*n*	+0·91	−4·2 18
17	14 16 33·4	+0 42·38	+2 53·8	12-8	F.	...	9·5657*n*	...	0·0500*n*	+1·03	−4·3 19
20	13 45 48·2	−0 25·09	−3 16·3	12-8	F.	18 38 19·64	9·5999*n*	−31 52 7·2	0·1329*n*	+1·14	−4·5 20
23	13 10 50·3	−1 12·27	+1 46·6	12 8	F.	18 30 29·87	9·6282*n*	−31 25 3 2	0·2079*n*	+1·26	−4·7 21

Adopted Mean Places of Comparison Stars.

Comp. Star No.	R.A. 1893·0. h m s	Dec. 1893·0. ° ′ ″	Authority.
1	15 44 10·19	−41 58 31·5	C.Z. XV. 3020.
2	15 55 14·89	−42 5 25·8	Equat. diff. from *a*.
a	16 4 53·29	−42 5 45·1	A.G.C. 21923.
3	16 15 0·10	−42 15 37·3	One Equat. diff. from *b*.
b	16 11 50·86	−42 24 40·5	A.G.C. 22082, Cape (1880).
4	16 19 42·76	−42 13 26·8	C.Z. XVI. 1303.
5	16 36 54·73	−42 11 18·3	C.Z. XVI. 2491.
6	16 43 2·48	−42 8 12·4	Equat. diff. from *c*.
c	16 46 26·78	−42 11 0·0	A.G.C., Cape (1880) and (1885).
7	17 34 45·14	−40 24 24·2	A.G.C. 23959.
8	17 40 44·55	−40 11 21·5	Equat. diff. from *d*.
d	17 40 6·10	−40 5 5·3	A.G.C. 24107, Cape (1885).
9	17 42 42·12	−40 3 18·4	A.G.C. 24182, Cape (1880).
10	17 49 22·25	−39 54 53·9	A.G.C. 24328.
11	17 49 57·88	−39 49 30·7	C.Z. XVII. 3294.
12	17 53 5·48	−39 39 27·6	A.G.C. 24431.
13	18 31 (22)	−36 37	$9\frac{3}{4}$ mag. = *e* { $-2^m\ 17^s{\cdot}98$; $+3'\ 15''{\cdot}1$.
e	18 33 (40)	−36 40	$8\frac{1}{2}$ mag.
14	18 27 (22)	−36 30	$8\frac{1}{2}$ mag.
15	18 32 (50)	−36 23	8 mag.
16	18 37 9·35	−35 44 47·6	A.G.C. 25565, Cape (1880).
17	18 35 22·36	−35 15 18·8	A.G.C. 25523.
18	18 41 (21)	−32 40	$9\frac{1}{2}$ mag. = *f* { $-0^m\ 25^s{\cdot}10$; $+2'\ 28''{\cdot}0$.
f	18 41 (46)	−32 42	$8\frac{1}{2}$ mag.
19	18 39 (6)	−32 20	9 mag.
20	18 38 43·59	−31 48 46·4	Equat. diff. from *g*.
g	18 40 15·99	−31 51 12·0	A.G.C. 25650.
21	18 31 40·88	−31 26 45·1	C.Z. XVIII. 1807.

Notes.

January 16, 18.—Very bad definition; comet very diffused.
February 19.—Comet bears as bright a wire in observing as a 10-mag. star.
April 14.—Comet faint, and a small star near it was troublesome.
April 23.—Comet near two stars; faint and difficult.

Ephemeris of the Fifth Satellite of Jupiter, 1893. By A. Marth.

Greenwich Noon. 1893.		P+90°	*a*	*b*	*l*−L.	Approx. Greenwich Times of greatest elongations.	
		°	″	″	°	h m	h m
Aug.	4	76·87	48·37	+2·64	292·14	17 12 E	23 11 W
	6	76·97	48·65	2·66	297·29	17 2 „	23 0 „
	8	77·07	48·93	2·68	302·44	16 51 „	22 50 „
	10	77·17	49·22	2·70	307·61	16 41 „	22 40 „
	12	77·26	49·51	2·72	312·79	16 31 „	22 29 „
	14	77·35	49·80	2·74	317·98	16 20 „	22 19 „
	16	77·43	50·10	2·76	323·18	16 10 „	22 9 „
	18	77·51	50·41	2·78	328·39	16 0 „	21 58 „
	20	77·59	50·72	2·80	333·61	15 49 „	21 48 „
	22	77·66	51·04	2·83	338·85	15 39 „	21 38 „
	24	77·73	51·36	2·85	344·09	15 28 „	21 27 „
	26	77·80	51·68	2·87	349·34	15 18 „	21 17 „
	28	77·86	52·00	2·89	354·61	15 7 „	21 6 „
	30	77·91	52·33	2·91	359·89	14 57 „	20 56 „
Sept.	1	77·96	52·67	2·94	5·18	14 46 „	20 45 „
	3	78·01	53·00	2·96	10·48	14 36 „	20 34 „
	5	78·05	53·34	2·98	15·80	14 25 „	20 24 „
	7	78·08	53·68	3·00	21·12	14 15 „	20 14 „
	9	78·11	54·02	3·03	26·46	14 4 „	20 3 „
	11	78·14	54·36	3·05	31·81	13 53 „	19 52 „
	13	78·16	54·70	3·07	37·17	13 43 „	19 41 „
	15	78·17	55·05	3·10	42·54	13 32 „	19 31 „
	17	78·18	55·39	3·12	47·93	13 21 „	19 20 „
	19	78·19	55·73	3·14	53·32	13 10 „	19 9 „
	21	78·19	56·07	3·17	58·73	13 0 „	18 58 „
	23	78·18	56·41	3·19	64·15	12 49 „	18 47 „
	25	78·17	56·74	3·21	69·58	12 38 „	18 37 „
	27	78·15	57·07	3·23	75·02	12 27 „	18 26 „
	29	78·13	57·40	3·26	80·47	12 16 „	18 15 „
Oct.	1	78·10	57·72	3·28	85·94	12 5 „	18 4 W
	3	78·06	58·04	3·30	91·41	11 54 „	23 52 E
	5	78·03	58·35	3·32	96·89	11 44 „	23 41 „
	7	77·98	58·66	3·34	102·39	11 33 „	23 31 „
	9	77·93	58·96	3·36	107·89	11 22 „	23 20 „
	11	77·88	59·24	3·37	113·40	11 11 „	23 9 „
	13	77·82	59.52	+3·39	118·92	11 0 E	22 58 E

Greenwich Noon. 1893.	P+90°	*a*	*b*	*l*−L.	Approx. Greenwich Times of greatest elongations.	
	°	″	″	°	h m	h m
Oct. 15	77·76	59·79	+3·41	124·45	10 49 E	22 47 E
17	77·69	60·05	3·42	129·99	10 38 „	22 35 „
19	77·62	60·29	3·44	135·53	10 27 „	22 24 „
21	77·54	60·53	3·45	141·08	10 15 „	22 13 „
23	77·46	60·75	3·46	146·63	10 4 „	22 2 „
25	77·38	60·95	3·47	152·19	9 53 „	21 51 „
27	77·29	61·14	3·48	157·76	9 42 „	21 40 „
29	77·20	61·32	3·49	163·33	9 31 „	21 29 „
31	77·11	61·48	3·50	168·90	9 20 „	21 18 „
Nov. 2	77·02	61·62	3·51	174·47	9 9 „	21 7 „
4	76·92	61·75	3·51	180·05	8 58 „	20 56 „
6	76·82	61·86	3·51	185·63	8 47 „	20 45 „
8	76·72	61·95	3·52	191·20	8 36 „	20 33 „
10	76·62	62·02	3·52	196·78	8 24 „	20 22 „
12	76·52	62·07	3·51	202·35	8 13 „	20 11 „
14	76·41	62·11	3·51	207·92	8 2 „	20 0 „
16	76 31	62·12	3·51	213·49	7 51 „	19 49 „
18	76·20	62·11	3·50	219·05	7 40 „	19 38 „
20	76·10	62·09	3·49	224·60	7 29 „	19 27 „
22	76·00	62·05	3·48	230·15	7 18 „	19 16 „
24	75·90	61·98	3·47	235·70	7 7 „	19 5 „
26	75·80	61·90	3·46	241·23	6 56 „	18 53 „
28	75·70	61·80	3·45	246·76	6 45 „	18 42 „
30	75·60	61·68	3·43	252·28	6 34 E	18 31 „
Dec. 2	75·51	61·55	3·42	257·78	12 22 W	18 20 „
4	75·42	61·39	3·40	263·28	12 11 „	18 9 „
6	75·33	61·22	3·38	268·76	12 0 „	17 58 „
8	75·24	61·03	3·36	274·24	11 49 „	17 47 „
10	75·16	60·83	3·34	279·70	11 38 „	17 37 „
12	75·08	60·61	3·32	285·14	11 27 „	17 26 „
14	75·00	60·38	3·30	290·57	11 16 „	17 15 „
16	74·93	60·13	3·27	295·99	11 6 „	17 4 „
18	74·86	59·87	3·25	301·39	10 55 „	16 53 „
20	74·80	59·60	3·22	306·78	10 44 „	16 43 „
22	74·74	59·32	3·20	312·15	10 33 „	16 32 „
24	74 68	59·02	3·17	317·51	10 23 „	16 21 „
26	74·63	58·72	3·14	322·85	10 12 „	16 11 „
28	74·59	58·71	3·12	328·17	10 1 „	16 0 „
30	74·55	58·09	+3·09	333·48	9 51 W	15 50 E

Greenwich Noon. 1894.		P+90°	*a*	*b*	*l*−L.	Approx. Greenwich Times of greatest elongations.	
		°	″	″	°	h m	h m
Jan.	1	74·51	57·76	+3·07	338·77	9 40 W	15 39 E
	3	74·48	57·43	3·04	344·05	9 30 „	15 29 „
	5	74·45	57·09	3·01	349·31	9 19 „	15 18 „
	7	74·43	56·74	2·98	354·55	9 9 „	15 8 „
	9	74·41	56·39	2·96	359·77	8 58 „	14 57 „
	11	74·39	56·04	2·93	4·98	8 48 „	14 47 „
	13	74·39	55·69	2·90	10·17	8 38 „	14 37 „
	15	74·38	55·33	2·87	15·35	8 27 „	14 26 „
	17	74·38	54·98	2·85	20·51	8 17 „	14 16 „
	19	74·39	54·62	2·82	25·66	8 7 „	14 6 „
	21	74·40	54·26	2·79	30·79	7 57 „	13 55 „
	23	74·42	53·90	2·77	35·90	7 47 „	13 45 „
	25	74·44	53·54	2·74	41·00	7 36 „	13 35 „
	27	74·46	53·19	2·71	46·09	7 26 „	13 25 „
	29	74·49	52·83	2·69	51·16	7 16 „	13 15 „
	31	74·53	52·48	2·66	56·21	7 6 „	13 5 „
Feb.	2	74·57	52·13	2·64	61·26	6 56 „	12 55 „
	4	74·61	51·78	+2·61	66·29	6 46 W	12 45 E

The rectangular coordinates x and y of the satellite in reference to the axes of *Jupiter's* disc, or its apparent distances from the polar axis and from the direction of the equatorial diameter of the disc, are found by

$$x = a \sin (l - \mathrm{L})$$
$$y = b \cos (l - \mathrm{L}),$$

where a and b denote the semi-axes of the apparent orbit and $l - \mathrm{L}$ the satellite's orbital longitude reckoned from the point which is in superior conjunction in reference to the Earth. The differences between successive values of $l - \mathrm{L}$ for an interval of two days vary between 1445°·03 and 1445°·58. The assumed daily rate of orbital motion is 722°·645, corresponding to a period of revolution of $11^{h}\ 57^{m}\ 21^{s}\cdot88$, the uncertainty of which is probably within a second of time, and will be reduced to a fraction by the first trustworthy measurements of x made at a sufficient distance both before and after a greatest elongation. The position-angle P+90° of the equatorial diameter of the disc is added, as it is desirable that the rectangular coordinates of the satellite should be measured in the computed directions of the axes of the disc.

Col. Cooper's Observatory:
Markree, Collooney, Ireland.

Erratum in Mr. Stone's Paper, "Monthly Notices," Vol. LIII., page 423, 15*th line from top.*

For Moon's mass = n^2a^3, *read* Earth's mass + Moon's mass = n^2a^3.

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